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Municipal Plan for Integrated Solid Waste Management (MPI-SWM) in the state of Piauí: A portrait of Coastal Cities

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ABSTRACT

The MPI-SWM is an essential instrument of the National Solid Waste Policy (NSWP) that articulates the management of municipal waste with the state plan and, in turn, dialogues with the national one. The evaluation of the MPI-SWM is where the municipal manager detects if the plan meets the NSWP requirements and which local actions (municipal level) have succeeded in achieving the municipal plan goals. The objective was to evaluate the MPI-SWM of the coastal cities of Piauí, according to what the NSWP prescribes. To achieve this, the specific instrument for this purpose, consisting of 21 indicators and four indices, was used. The municipalities' indicators were mostly evaluated as poor and with indices below the recommended literature. Overall, the instrument's indicators indicate the municipalities' difficulty in meeting the NSWP guidelines. The study brings theoretical and managerial contributions. In the theoretical field, it expands understanding of the situation of coastal municipalities, members of the tourist route composed of three states, belonging to an environmental protection area, located in the Brazilian northeast, regarding the local management of their waste. In the managerial field, the findings serve as support for the revision of MPI-SWM and an indicator at the state level, for the formulation of actions that mobilize managers to elaborate the local plan and/or urge them to create intermunicipal consortia focusing on proper waste disposal.

KEYWORDS: Waste. Municipalities. National Solid Waste Policy.

1 INTRODUCTION

The National Solid Waste Policy (NSWP), created in 2010, is one of the environmental policies that gathered orientations, guidelines and tools in a documentation with regard to solid waste. The NSWP also stands out in the environmental field, as its text is in accordance with the *Política Nacional de Educação Ambiental* (*PNEA* - Law no. 11.445/77), or National Environmental Education Policy (NEEP), National Basic Sanitation Policy (Law no. 11.445/77) and the Public Consortia Law (Law no. 11.107/05).

In 2022, the NSWP was amended and published in the presidential decree no. 10.936, January 12th, 2022. This document reinforces the NSWP by clarifying deficiencies in its text and stablishing another instrument aimed at improving the implementation of the policy. Such improvements are noticed, for instance, in the detailing of shared responsibility, in simplified solid waste management plans for microenterprises and small businesses, in the Reverse Logistics National Plan, and in assigning responsibility for proper waste separation to cities that have selective collection.

The Municipal Plan for Integrated Solid Waste Management (MPI-SWM) is an important instrument of the NSWP that coordinates the management of municipal waste with the state plan and, in turn, interacts with the national plan. According to NSWP (2010), in items I to XIX of article 19 of the law, municipalities are responsible for the development and management of the MPI-SWM.

Despite the NSWP having existed for over ten years, a reality that contradicts what it determines is observed. In this sense, the coverage of regular waste collection and the MPI-SWM illustrate this situation well. Over the Years following the approval of this policy, Brazil continues to produce garbage on a large scale. In 2019, the country had an increase of 19%, about 79 million tons/year of solid waste. In the Northeast region, for example, the states of Maranhão, Piauí, and Ceará have the lowest indicators of garbage collection (ABRELPE, 2020).

In the state of Piauí, only 789,000 (Tons/Year – 69%) of waste was collected out of the 1,141,355 (Tons/Year) generated. It should be noted that this indicator is aggraveted by the absence of the MPI-SWM, as only 84 out of 224 municipalities in the state have the mentioned plan (ABRELPE, 2020). The territory of the coastal plain, located in the north of the state, contains only 11 municipalities, and of these, only six municipalities presented the MPI-SWM in 2019 (PIAUÍ, 2019). In this context, Parnaíba stands out for being the largest city in the territory and the second most representative city in the state, with 153,863 inhabitants in 2021 (CEPRO,

2021). In addition to Parnaíba, the other cities with MPI-SWM on the coast are Ilha Grande (9,487/inh.) and Cajueiro da Praia (7,704/inh.).

Hence, considering the relevance of this research field and the incipiency in the literature, the objective of this paper is to evaluate the Municipal Plan for Integrated Solid Waste Management (MPI-SWM) of the coastal cities in the state of Piauí, based on the guidelines of the National Solid Waste Policy (NSWP). The paper is divided, in addition to this section, into a theoretical framework that will address the NSWP and thethe MPI-SWM, later presenting the research environment, the methodological path, analysis and discussion of the results, and finally, the concluding remarks.

2 THEORETICAL FRAMEWORK

Public policies are important instruments created by governments with the aim of providing assistance or services to the population in order to ensure rights established by law and strengthen the common good. Due to the collective purpose of these policies, the effective participation of various social actors is necessary in the conception and elaboration of guidelines, which is why the State's actions are not always straightforward.

In this regard, a public initiative or program consists of instruments that are devised to attain the program's objectives. These actions take shape in the form of "organizational frameworks that are proficient in generating depictions of the audience they are directed towards" (TEIXEIRA; ARAÚJO, 2020, p.5).

Environmental issues have sparked debates in recent centuries, promoting the creation of legal devices that sustainably protect the environment. The NSWP is one such device that serves as an important tool for environmental policies. As a policy that presents national-level guidelines and directions, it naturally brings to light challenges related to its applicability in various corners of the country and with regard to the diverse peculiarities of each locality.

One of these challenges is perceived in article 10 of the NSWP, in the perspective of integrated management, where municipalities are responsible for the waste produced in their territory. In this sense, various actors (e.g. environmental department, technicians, and society) come into play for the elaboration of the MPI-SWM, which aims mainly to provide solutions for urban waste, such as how it will be managed, which protocol will be adopted for different types of waste (organic, hospital, construction, and recyclable), among other aspects (KLEIN; GONÇALVES-DIAS; JAYO, 2018; SILVEIRA; CLEMENTINO, 2017).

It should be noted that a plan, from a strategic perspective to achieve the objective of NSWP, goes beyond a mere proposition of possible actions. It is a course of action that defines tasks, identifies responsible actors for each action, how they complement or interrelate with one another, and the role of actors in this collective construction called an integrated plan (MINTZBERG; QUIN, 2001; MINTZBERG; AHLSTRAND; LAMPEL, 2000).

Leme (2016) highlights that despite the allocation of responsibility in the national policy to states and municipalities, few political representatives have an environmental agenda in their government plans. Other authors not only agree with this position, but also add that the absence of an integrated waste management plan in the municipality has become a major obstacle to the implementation of the NSWP in Brazil (TEIXEIRA; ARAÚJO, 2020).

On the other hand, when available, the municipality tends to enable the implementation of the MPI-SWM and promote debates with society about the goals outlined in the plan. Recent literature reinforces that, in turn, local management must, alongside its

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commitment to environmental issues, improve the structure of the environmental department and train technicians to ensure a satisfactory implementation of the MPI-SWM (CHAVES; SIMAN; SENA, 2020b; MARINO; CHAVES; SANTOS JUNIOR, 2018; TEIXEIRA; ARAÚJO, 2020).

Such a position aims to combat a reality exposed by Waldman (2013) of plans with technical flaws and without clear goals. This is why it is also important to evaluate the MPI-SWM, as it is through evaluation that it is detected whether the plan meets the requirements of the NSWP and how successful local actions (at the municipal level) have been in achieving the goals of the municipal solid waste plan. Some authors who have delved into the subject highlight that the evaluation of the MPI-SWM allows the municipal manager to visualize their performance in relation to the demands of the NSWP and to channel their efforts towards improving the indicators of the MPI-SWM (CHAVES; SIMAN; SENA, 2020a).

3 CHARACTERIZATION OF THE RESEARCH ENNVIRONMENT

The coastal plain of Piauí (Chart 1) is composed of eleven municipalities, of which six cities have the MPI-SWM. For the present study, the municipalities of Parnaíba, Ilha Grande, and Cajueiro da Praia were selected, which make up the state's coastline and are part of the Rota das Emoções, an important itinerary that connects the tourist region of Maranhão, Piauí, and Ceará.

Chart 1 – Characterization of the cities comprising the coastal plain

Cities	Has the MPI-SWM	Number of Inhabitants
Parnaíba	X	153.863
Ilha Grande	X	9.487
Cajueiro da Praia	X	7.704
Cocal dos Alves	X	6.180
Bom Princípio do Piauí	X	5.670
Caraúbas do Piauí	X	5.910
Buriti dos Lopes		19.832
Caxingó		5.477
Cocal		27.901
Luís Correia		30.558
Murici dos Portelas		9.258

Source: PIAUÍ (2019); IBGE (2022).

As depicted in figure 1, the three municipalities, by virtue of their size, population, and location, are capable of delineating the reality of the coast and a portion of the coastal plain with respect to their MPI-SWM.

Parnaíba is a city located in the coastal plain of the state of Piauí, with a population of approximately 154 thousand inhabitants. Following the state capital Teresina, the municipality stands out as having the highest GDP in the state, with its main economic activities being commerce and wind power generation. The gross value added (GVA) of the services sector, which includes retail trade of general merchandise, retail sale of fuels, and wholesale trade of beverages, corresponds to the amount of R$ 1.305.009 billion (CEPRO, 2019, 2021).

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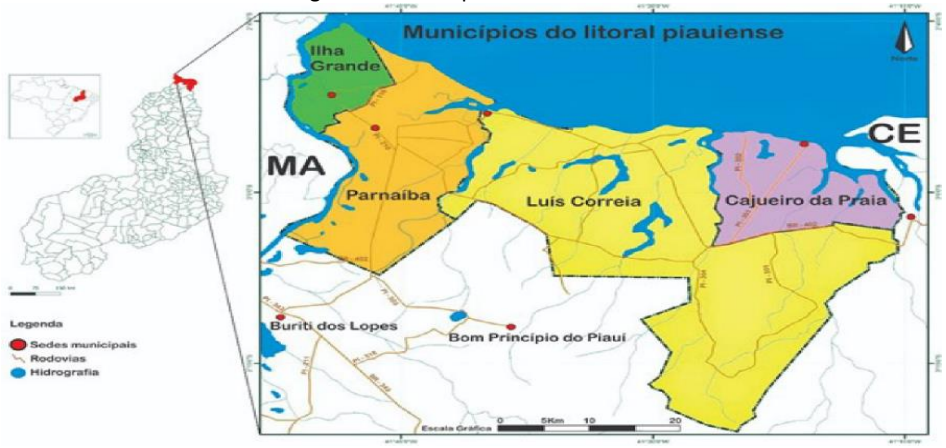
Figure 1 – Municipalities of the coast of Piauí



Source: BRAGA; GUZZI (2021).

Moreover, the municipality, which is the most populous in the coastal plain and has a per capita GDP of R$ 17,163.13, also has areas for the promotion of irrigated agriculture (Coastal Tablelands) and industry and exports (Export Processing Zone - EPZ). In the Coastal Tablelands, there are significant projects promoted by the National Department of Works Against Drought (ND-WAD), with 2.5 thousand hectares, where certified organic production is encouraged. Of this area, 80% is occupied by the production of acerola, watermelon, coconut, papaya, cashew, mango, guava, and generates around 2,400 direct and indirect jobs (BRASIL, 2020; IBGE, 2022).

The EPZ, an area that benefits from federal tax incentives and support from the state and municipality for international trade, was inaugurated in February 2022 and aims to host companies in the pharmaceutical chemicals, carnauba wax, babassu, leather and hides, food, precious stones and minerals, biofuels, and biotechnology and nanotechnology sectors (ZPE, 2022).

The municipality of Ilha Grande is situated in a geographically privileged position on the coast of the state, as it offers tourism through the Parnaíba River, which divides Piauí from Maranhão and also has access to the Atlantic Ocean. The municipality has approximately 9,500 inhabitants and its economy is based on fishing, tourism, commerce, and the wind farms that have been populating its territory since 2014 (CEPRO, 2018).

Due to its small size and limited area for expansion, the municipality relies on a volatile tourism industry that intensifies during weekends or seasonal periods (e.g. July and December) when there is a higher flow of tourists in the nearby city of Parnaíba, who travel to explore the Parnaíba Delta. The Delta is an environmental protection area (EPA) created in 1996, which covers 307,590.51 hectares of protected land, benefiting not only the cities along the coast of Piauí but also municipalities in neighboring states of Maranhão and Ceará (BRAGA; GUZZI, 2021; INSTITUTO CHICO MENDES DE CONSERVAÇÃO DA BIODIVERSIDADE, 2021).

The municipality of Cajueiro da Praia has a population of 7,700 and is located to the east, bordering the state of Ceará. The local economy is mainly driven by fishing, shrimp farming, and tourism. The city is privileged to host the largest cashew tree in the world and to have a rich fauna (SILVA, 2013; BRAGA; GUZZI, 2021). Likewise, the area is noteworthy for its potential for sports and adventure tourism, such as kitesurf and canoeing.

Given the city's territorial area of 283.86 km², it needs to effectively manage its space in relation to the economic interests aimed at expanding built-up areas, stemming from the

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tourism demand, as it holds important marine biodiversity, a natural breeding ground for manatees and leatherback and hawksbill sea turtles (BRAGA; GUZZI, 2021; DUTRA; PEREIRA, 2015).

4 METHODOLOGICAL PATH

This study is classified as exploratory and descriptive. The research strategy used was a multiple case study design. In terms of its nature, it is both qualitative and quantitative. It is qualitative in nature because it involves a bibliographic study and the analysis of public documents and websites. It is also quantitative as it quantifies the evaluation indicators of the MPI-SWM.

The documentary phase occurred through the analysis of documents available in the official gazette of the municipality of Parnaíba - PI: Municipal Basic Sanitation Policy - MBSP (Law no. 3,352/19) and Integrated Solid Waste Management Plan of the Municipality (Law no. 3,341/18). The MPI-SWM and MBSP of the other cities were obtained either on the website of each city hall or directly with the respective secretaries of the environmental department, through the contact available on the website. In addition, additional information was used, when necessary, on the websites of the city halls.

The criteria for choosing the municipalities of Parnaíba, Ilha Grande, and Cajueiro da Praia were based on the following aspects: i) representativeness in the state and territory in terms of population and GDP (R$ 2.6 billion); ii) location, especially for being headquarters of the Environmental Protection Area of the Delta do Parnaíba; iii) richness of fauna and flora. In addition, their plans deserve attention for being tourist cities, located on the coast of the state, and therefore become susceptible to additional overload from solid waste generation.

The tool used to assess the MPI-SWM was proposed by Chaves, Siman, and Sena (2020a). It consists of twenty-one MPI-SWM indicators, which are evaluated based on three criteria: compliance, sufficiency, and condition. The compliance criterion was assessed as either 'fulfilled' (score 1) or 'not fulfilled' (score 0). Sufficiency takes into account the information provided in the plan and its clarity regarding the indicator being evaluated. It was evaluated, as indicated by the authors, with a score of 2 when the plan contains complete information on how waste management is carried out regarding the evaluated indicator, and a score of 1 when there is a lack of information. The condition criterion accepts three scores. In this sense, a score of 3 (good evaluation) corresponds to the well-described indicator, while a score of 2 is considered regular and a score of 1 is characterized as poor, according to the evaluation description presented by the authors.

The product of the criteria scores (multiplication of compliance, sufficiency, and condition scores) presented above will lead to five partial indicator scores in Table 2. The instrument also evaluates four indices: the MPI-SWM Compliance Index (MCI), the MPI-SWM Quality Index (MQI), the MPI-SWM Complexity Index (MCIN), and the MPI-SWM Potential Index (MPI). The values of MCIN and MPI are obtained by multiplying the MQI score by weighting factors (weights). The value of each weight was pre-established by the authors when proposing the instrument.

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Chart 2 – Partial scores of the indicators

Score	Result
6	Fulfilled Indicator
4	
2	
1	Incomplete Indicator
0	Unfulfilled Indicator

Source: Chaves, Siman and Sena (2020a, p. 176).

In order to evaluate the MPI-SWM (MQI), the value of the product of the scores of the criteria of compliance, sufficiency, and condition was utilized, according to the formula: MQI = compliance score x sufficiency score x condition score. In this context, up to five partial scores of the indicators can be obtained, as shown in Chart 2, along with the corresponding classification assigned to the results (CHAVES; SIMAN; SENA, 2020a).

In order to calculate the MPI-SWM Complexity Index (MCIN) and the MPI-SWM Potential Index (MPI), the following equations were employed: MCIN = MQI x W1 and MCIN = MQI x W2, where W1 and W2 represent weighting factors assigned to each indicator, as per Chaves, Siman, and Sena (2020a).

Lastly, for the calculation of the total value of the MPI-SWM Compliance Index (MCI) - which is the sum of the scores for compliance, complexity, potential, and quality indices - the scores for each index were added up and subsequently analyzed based on the individual compliance percentage of each index in relation to its respective maximum score, which varies according to the municipality's population size (greater or smaller than 20,000 inhabitants), as shown in Chart 3. Therefore, the maximum values used were different among Parnaíba (above 20,000 inhabitants), Ilha Grande, and Cajueiro da Praia (below 20,000 inhabitants) (Chaves, Siman, & Sena, 2020a).

Chart 3 – Maximum scores of indices for municipalities with more than 20 thousand inhabitants

Municipality	MCI	MQI	MCIN	MPI
Above 20,000 inhabitants	21	126	171	195
Below 20,000 inhabitants	17	102	141	159

Source: Chaves, Siman and Sena (2020a, p. 177).

It is worth highlighting that the MCI indicates compliance with the minimum content defined by the Municipal Plan for Integrated Solid Waste Management (MPI-SWM), as it represents the sum of the compliance scores for the indicators. The MQI score, as a result of the multiplication of the criteria, portrays the quality of the Municipal Plan for the MPI-SWM based on the available information. The MCIN index symbolizes the complexity of the plan in relation to the complexity, time, and resources spent on the development of each item. This index takes into consideration the effort made by the municipality to meet the requirements demanded by the National Solid Waste Policy (NSWP) for the MPI-SWM, mainly due to the complexity of these requirements. The MPI index allows for an assessment of the potential for plan implementation, as it depends on factors inherent to the local government - such as the technical capacity of the team that will implement the plan, as well as the continuity of actions after the change of municipal managers.

5 ANALYSIS AND DISCUSSION OF THE RESULTS

In Table 1, we can find the evaluation form of the Parnaíba MPI-SWM, with the respective scores attributed to the 21 evaluated indicators, as well as the values of the MPI-SWM Compliance Index, MPI-SWM Quality Index, MPI-SWM Complexity Index, and MPI-SWM Potential Index. Table 2 presents the evaluation form of the MPI-SWM of the municipalities of Ilha Grande and Cajueiro da Praia carried out jointly.

Due to the fact that the municipality of Parnaíba has the MPI-SWM, the evaluation was initially guided by the document and, when necessary, information was sought in the Municipal Basic Sanitation Policy that could complement what was required by each indicator.

From Table 1, it is noticeable that the MPI-SWM fails to meet all the indicators, indicating that it is deficient in meeting the requirements set out in Article 19 of NSWP (BRASIL, 2010). The unfulfilled indicators were 1, 2, 4, 8, 12, 15, 16, 18, 20, and 21. They reveal that the plan did not have participatory events that involved the community in its elaboration and did not explicitly state which individuals (support group) would guide and monitor the participatory process. It does not mention the technical committee responsible for the plan's development and does not present availability for short and long-term joint solutions.

The Municipal Plan also does not clearly specify the indicators that will be used to verify the operational and environmental performance of urban cleaning services and solid waste management. In this sense, compliance with this indicator, when combined with the previous indicator (11 - Periodic Review of MPI-SWM), helps guide the manager and the environmental department on how and which issues need more attention when revising the MPI-SWM.

At the same time, the plan includes the work of incentivizing, including, and supporting waste pickers, but it does not promote the creation of cooperatives or any type of association of collectors of reusable and recyclable materials. Regarding waste valorization, the plan also makes no mention of it. According to Piauí (2019), the municipality still has a controlled landfill. When analyzed with the previous indicator, the absence of valorization is noted, since the MPI-SWM of the municipality does not envisage any benefit from the waste, either by its own initiative or by third parties (cooperatives/associations).

The indicator 18 (establishment of goals) is in line with the others, given the absence of goals and, moreover, the definition of programs, plans, and projects throughout the MPI-SWM. One of the indicators that stands out in the MPI-SWM is the lack of information about environmental liabilities (indicator 20). Thus, the municipality assumes the non-existence or lack of knowledge about these areas (liabilities) and therefore it is unclear how it intends to manage areas contaminated by solid waste, even in the controlled landfill of the municipality. At the same time, by not fulfilling this indicator, the plan goes against what is recommended in Article 51 (II) of Decree No. 10,936 (BRAZIL, 2022).

At the same time, within the list of alarming indicators, the municipality remains unaware of or disregards factors/sources that could trigger impacts arising from critical or unexpected situations. Consequently, it is uncertain which procedures to adopt for prevention or correction. The presence of the controlled landfill without monitoring, in itself, even with lower risk, already represents a source of risk for the municipality that requires preventive actions (indicator 21).

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Table 1 – Parnaíba Evaluation Form

	COMPLIANCE (CPL) 0 = No 1 = Yes	SUFFICIENT (SUFF) 1 = not sufs. 2 = suff.	CONDITION (CON) 1 = Poor 2 = Fair 3= Good	**MQI - the MPI-SWM Quality Index** **CPL x SUFF x CON**	**W1 (MCIN)**	**MCIN (MQI x W1)**	**W2 (MPI)**	**MPI (MQI x W2)**
1 – Society's participation	0	1	1	**0**	1,5	**0**	2	**0**
2 – Support group	0	1	1	**0**	1	**0**	2	**0**
3 – MPI-SWM dissemination	1	2	2	**4**	1	**4**	1,5	**6**
4 – MPI-SWM steering committee	0	1		**0**	1	**0**	1,5	**0**
5 – Waste diagnosis	1	2	2	**4**	2	**8**	1,5	**6**
6 – Procedures for waste management	1	2	3	**6**	2	**12**	1,5	**9**
7 – Areas for final disposal	1	1	1	**1**	1,5	**1,5**	1,5	**1,5**
8 – Intermunicipal consortia	0	1	1	**0**	1,5	**0**	1,5	**0**
9 - Development of Waste Management Plans and Reverse Logistics	1	2	1	**2**	1	**2**	1	**2**
10 – Compatibility with other plans	1	1	1	**1**	1,5	**1,5**	1,5	**1,5**
11 – Periodic review of MPI-SWM	1	2	2	**4**	1	**4**	1,5	**6**
12 – Operational and environmental performance*	0	1	1	**0**	1,5	**0**	2	**0**
13 – Qualification of those involved*	1	1	1	**1**	1	**1**	1,5	**1,5**
14 – Environmental education	1	1	1	**1**	1,5	**1,5**	2	**2**
15 – Inclusion of waste pickers	0	1	1	**0**	1,5	**0**	1,5	**0**
16 – Valuation of waste*	0	1	1	**0**	1,5	**0**	1,5	**0**
17 – Regulation of Solid Waste Management Public Service	1	2	2	**4**	1,5	**6**	2	**8**
18 – Setting goals	0	1	1	**0**	1,5	**0**	1,5	**0**
19 – Delimitation of government responsibilities	1	2	3	**6**	1	**6**	1,5	**9**
20 – Environmental liabilities	0			**0**	1,5	**0**	1	**0**
21 – Prevention and correction actions*	0			**0**	1	**0**	1	**0**
MCI	**11**	-	-	-	-	-	-	-
MQI	-	-	-	**34**	-	-	-	-
MCIN	-	-	-	-	-	**47,5**	-	-
MPI	-	-	-	-	-	-	-	**52,5**

Source: Prepared by the author, 2022.

With respect to the MPI-SWM indicators of Parnaíba, calculated from the indicators, it is generally observed that the plan requires revision, since the MCI received a score of eleven, which corresponds to approximately fifty percent (52%) of the total value, (21) of the index. Such a result reflects in the other indices that assess the plan's performance, MQI, MCIN, and MPI. The quality of the MPI-SWM, according to the MQI, has a score of 34, indicating that the plan has only twenty-seven percent (27%) of the maximum value assigned to this index (Chart 3). According to the literature, only values above 67% indicate adequate indices (CHAVES; SIMAN; SENA, 2020a).

The MCIN corroborates with the MQI by revealing that the municipality has a low level of complexity, representing only 28% of the maximum value of 171 assigned to this index. This value reveals that the municipality has a low level of complexity. This index reinforces the municipality's low commitment to meeting the requirements of the NSWP, and this may be confirmed by the lack of information or depth of guidance and procedures in the local plan. However, according to Chaves, Siman, and Sena (2020a), some consideration is necessary regarding the MCIN, as municipalities with these characteristics may not present a good indicator because they are focused on changing from controlled landfills to sanitary landfills, leaving managerial capacity (complexity) as an accessory. Regarding the MPI, whose value was 52.5, corresponding to 26.9% of the maximum value assigned to this indicator, it signals low capacity for implementing the MPI-SWM.

Ilha Grande and Cajueiro da Praia are smaller municipalities, with less than 20,000 inhabitants, which are important in the process of evaluation and understanding of the reality of the Piauí coast, not only because they are coastal cities that have part of their territory in an Environmental Protection Area (EPA), but also because they can represent how waste management is carried out, especially due to the driving factor of waste generation in small cities, which is tourism.

The MPI-SWM of both municipalities were elaborated during the same period as a result of an action developed by SEBRAE, SEMAR and partners, with the aim of formalizing a consortium with the city of Parnaíba, as well as the same methodology for plan elaboration. Therefore, it is relevant to highlight that both cities presented the same performance in all items. Thus, the analysis that follows will address both. As a result, it was chosen to present the evaluation of both cities only in Table 2.

Ilha Grande (IG) and Cajueiro da Praia (CP) failed to comply with items 9, 11, 13*, 15, 16* and 21* (Table 2), as they remained with a score of zero. Of these, the items marked with an asterisk (*) are exempted for small municipalities. In this sense, by observing what the law prescribes, the plan discriminates the types of solid waste and makes some propositions on how to manage them, which was deemed vague regarding the operationalization of waste treatment or reverse logistics. At the same time, it also does not include programs or any public policy that involves waste pickers for the valorization of waste in the municipality.

Regarding the MPI-SWM of the city of IG, created in 2008, for example, it is estimated that the sum of the waste produced by the permanent and floating population will be able to generate approximately 1.9 thousand tons in 2022. The incentive for the organization of waste pickers is important as an effort to enable the processing of waste and reverse logistics, while reducing the amount discarded in the municipal landfill.

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It should be emphasized that such incentive aims to minimize the amount of waste discarded in inappropriate locations, which would result in a positive effect as a result of the processing of these wastes. Similarly, the two municipalities define the Voluntary Delivery Points (VDPs) as specific locations for receiving recyclable materials and for this, they expect to rely on waste pickers who, according to the plan, can act in an associated or individualized manner.

The city of CP has three VDPs and IG has two. In both municipalities, the VDPs are responsible for receiving not only recyclable materials but also tree branches, construction and demolition waste, with a limit of up to 1m³ or 50 bags of 20 liters. In addition, from the collection at these points, the plans list proposals that are limited to merely suggesting possible actions for the processing of the collected material.

It is worth noting that the NSWP calls on the federal entities of the country to expend coordinated and strategic efforts, where each actor assumes commitments defined by the policy in relation to solid waste. At the extreme end of this relationship, municipalities, through a plan that integrates various agents (e.g. departments and the community) towards this goal, have the responsibility to elaborate their MPI-SWM and apply it in order to properly manage their waste.

A plan goes beyond mere suggestions, as it defines how to do it, the responsible parties for each stage, and explicitly lays out the operationalization of activities. This integrated view of what a plan is, supported by Mintzberg and Quin (2001), emphasizes that a plan is the first step towards achieving a goal effectively. Here, a plan is understood as a direction on how to go from here (absence of a plan with directions) to there (well-defined course of action) (MINTZBERG; AHLSTRAND; LAMPEL, 2000).

Item 11 (Periodic review of the MPI-SWM) points to a common reality in the two municipalities regarding the non-revision of the municipal plan. According to the NSWP (2010), plans need to be reviewed every four years. In this sense, for both municipalities, the plan is limited to assigning responsibility to the municipality and defining that updating must comply with federal legislation. Contrary to what is established by the NSWP, it was observed that CP updated its MPI-SWM in 2010 and IG continues in its initial version from 2008.

In general, the two municipalities do not differ from Parnaíba, and therefore, require a collective effort in their jurisdictions to review and update the MPI-SWM, as all indicators, individually, remained as scores lower than four (column of MQI). According to Chaves, Siman and Sena (2020a), the individualized look of each score represents an important indicator for the municipal management to reflect on the possible difficulties of implementing the action evaluated in the indicator and make the update necessary.

Regarding the MCI index (88%), both cities outperformed Parnaíba. This was due to their compliance with a higher number of indicators than the neighboring city, considering the maximum value (Chart 3) in relation to the total population. Despite meeting the requirements of the MPI-SWM, this did not translate into a better performance in which MQI corresponded to 27.5% of the maximum value, MCIN represented 26.6%, and MPI represented 29.6%. This situation occurs because the evaluation of these indices takes into account whether the indicators are sufficient and their condition (good, fair, and poor), in which the poor condition prevailed.

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Table 2 – Evaluation form for Ilha Grande and Cajueiro da Praia

	COMPLIANCE (CPL)	SUFFICIENT (SUFF)	CONDITION (CON)	**MQI**	**W1 (MCIN)**	**MCIN**	**W2 (MPI)**	**MPI**
	0 = No 1 = Yes	1 = not sufs. 2 = suff.	1 = Poor 2 = Fair 3= Good	**CPL x SUFFx CON**				
1 – Society's participation	1	2	1	**2**	1,5	**3**	2	**4**
2 – Support group	1	2	2	**4**	1	**4**	2	**8**
3 – MPI-SWM dissemination	1	2	1	**2**	1	**2**	1,5	**3**
4 – MPI-SWM steering committee	1	2	2	**4**	1	**4**	1,5	**6**
5 – Waste diagnosis	1	2	1	**2**	2	**4**	1,5	**3**
6 – Procedures for waste management	1	1	1	**1**	2	**2**	1,5	**1,5**
7 – Areas for final disposal	1	1	1	**1**	1,5	**1,5**	1,5	**1,5**
8 – Intermunicipal consortia	1	1	1	**1**	1,5	**1,5**	1,5	**1,5**
9 - Development of Waste Management Plans and Reverse Logistics	0	1	1	**0**	1	**0**	1	**0**
10 – Compatibility with other plans	1	2	1	**2**	1,5	**3**	1,5	**3**
11 – Periodic review of MPI-SWM	0	1	1	**0**	1	**0**	1,5	**0**
12 – Operational and environmental performance*	1	2	2	**-**	1,5	**-**	2	**-**
13 – Qualification of those involved*	0	1	1	**0**	1	**0**	1,5	**0**
14 – Environmental education	1	1	1	**1**	1,5	**1,5**	2	**2**
15 – Inclusion of waste pickers	0	1	1	**0**	1,5	**0**	1,5	**0**
16 – Valuation of waste*	0	1	1	**0**	1,5	**0**	1,5	**0**
17 – Regulation of Solid Waste Management Public Service	1	2	2	**4**	1,5	**6**	2	**8**
18 – Setting goals	1	1	1	**1**	1,5	**1,5**	1,5	**1,5**
19 – Delimitation of government responsibilities	1	2	1	**2**	1	**2**	1,5	**3**
20 – Environmental liabilities	1	1	1	**1**	1,5	**1,5**	1	**1**
21 – Prevention and correction actions*	0			**0**	1	**0**	1	**0**
MCI	**15**	-	-	-	-	-	-	-
MQI	-	-	-	**28**	-	-	-	-
MCIN	-	-	-	-	-	**37,5**	-	-
MPI	-	-	-	-	-	-	-	**47**

Source: Prepared by the author, 2022.

Lastly, as noted by Chaves, Siman, and Sena (2020a), the indices highlight the need for local management to improve their performance in meeting the indicators, especially in the other indices that displayed a percentage lower than what the authors consider as ideal (i.e., equal to or greater than 67% for each index).

6 CONCLUDING REMARKS

The aim of this study was to assess the MPI-SWM of the cities of Parnaíba-PI, Ilha Grande, and Cajueiro da Praia. Upon evaluation, it is deemed that the outcomes align with the intended objectives of this inquiry. The results have yielded several conclusions based on the evaluation.

The first pertains to the difficulty faced by municipalities in adhering to the guidelines outlined by the NSWP, nearly twelve years post-promulgation of the law. Parnaíba, despite being a large city with the second-highest GDP in the state, that thrives on commerce, fruit production, processing, and hosting wind energy parks, with a EPZ slated for operation in 2022, only approved its MPI-SWM in 2018. The other two cities, with a population of less than 20,000 inhabitants each, that rely primarily on service provision for tourism, had their plans respectively formulated/updated in 2008 and 2010, contravening the legislation regarding the maintenance of the MPI-SWM.

Considering the environmental impacts of these listed characteristics, municipalities increase their capacity to generate solid waste as employment and income grow, and therefore, regional development. Development, in turn, attracts people to live in the municipality, which, when added to the flow of visitors resulting from tourism, accentuates waste generation.

The situation in Parnaíba requires greater attention, as of the period of this study, as it only has a controlled landfill and needs to improve it to also receive waste from neighboring cities as a way to reduce environmental impact. This situation reflects in the indices evaluated in the MPI-SWM. They pointed to the difficulty of complying with NSWP and the lack of quality of plans due to the absence of detailed guidelines.

The low quality index led the plan to tolerate the low complexity of the indicators, revealing little effort from municipalities in the development of the MPI-SWM. Finally, the three cities mirror the reality of Brazilian municipalities regarding the structural difficulty of city governments in implementing and updating the plan. Therefore, it is concluded that the MPI-SWM of municipalities is considered inadequate and has insufficient grades in the indices (MCI, MCIN, MQI, and MPI), except for the MCI in the case of Ilha Grande and Cajueiro da Praia.

Overall, the tool used proved to be robust for its purpose and easy to use for academic and management purposes by municipalities. The possibility of evaluating the levels of compliance of each indicator and the adequacy indices of the local MPI-SWM to NSWP allowed for the correct measurement of each plan without neglecting the local and population particularities. This quality enabled the evaluation of the adequacy of each plan and even comparisons between them.

Finally, this study provides managerial contributions by allowing managers, together with the technical team of the environmental department, to consider the MPI-SWM evaluation carried out in this study when revising their plans. As a suggestion, it is believed that the revision, starting from the unmet and insufficient indicators, should be a priority for improving the MPI-

SWM of the three cities, as well as the definition of goals to be monitored every four years (the period for plan revision). The theoretical contribution is to broaden the knowledge regarding the evaluation of integrated solid waste management after the promulgation of NSWP in 2010. This contribution becomes relevant, as it occurs in the same year that the deadlines for municipalities to comply with decree no. 10.936/22 were extended.

As a proposal for future studies, it is suggested to expand the analysis to cities that have EPZ in order to compare and understand the reality of these municipalities, given the volume of waste generated by industries located in cities with EPZ. Another possibility would be to compare with coastal cities that have similar characteristics to those carried out in this study.

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